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An Assessment of Arctic Charr Stocks in Voisey Bay, Anaktalik Bay, and Okak Bay in 1984 with Stock Projections for 1985

by

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Abstract

Voisey Bay and Anaktalik Bay Arctic charr stocks have been under quota management since 1979. A quota was applied to the Okak Bay stock beginning in 1981. Total allowable catches for Voisey Bay, Anaktalik Bay, and Okak Bay stocks in 1984 were 16 t, 8.2 t, and 27 t respectively. Total landings in 1984, including an adjustment for losses of Voisey Bay and Anaktalik Bay charr in offshore fishing areas, were 9.2 t - Voisey Bay, 8.1 t - Anaktalik Bay, and 13.9 t - Okak Bay. In this assessment, the Voisey Bay - Antons area has been grouped as one stock unit. Total allowable catches in 1985, as determined from cohort analyses, are 25 t for the Voisey - Antons stock, and 27 t for Okak Bay. Insufficient new information was available to recommend a TAC for the Anaktalik Bay stock different from the 8.2 t quota of 1984.

Résumé

Les stocks d'ombles chevaliers de la baie Voisey et de la baie Anaktalik font l'objet d'une gestion par contingents depuis 1979. Un contingent a été établi pour le stock de la baie Okak à partir de 1981. Le total des prises admissibles (TPA) pour les stocks des baies Voisey, Anaktalik et Okak pour 1984 a été respectivement de 16, 8,2 et 27 t. Les débarquements totaux en 1984, y compris un ajustement pour les pertes d'ombles chevaliers dans les baies Voisey et Anaktalik attribuables à la pêche au large, ont été de 9,2 t pour la baie Voisey, de 8,1 t pour la baie Anaktalik et de 13,9 t pour la baie Okak. Dans cette évaluation les poissons de la baie Voisey et de la région d'Antons ont été groupés en un seul stock. Les TPA pour 1985, établis à partir des analyses par cohortes, sont de 25 t pour le stock Voisey - Antons et de 27 t pour celui de la baie Okak. Dans le cas du stock de la baie Anaktalik, on n'a pas obtenu de nouvelles données justifiant la recommandation d'un TPA différent de celui de 1984 (8,2 t).

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Introduction

Catch statistics from the Arctic charr fishery in Voisey Bay, Anaktalik Bay, and Okak Bay (Fig. 1) have been available since 1974. Quotas were applied to Voisey Bay and Anaktalik Bay charr stocks begining in 1979 and on Okak Bay stocks in 1981. Landings from these areas fluctuate with the amount of fishing effort directed on these stocks. In recent years this has been influenced both by the availability of charr within the inner bay areas and by the expansion of the fishery into the Hebron - Saglek region. The total allowable catches in Voisey Bay, Anaktalik Bay and Okak Bay in 1984 were 16 t, 6.1 t and 27 t respectively.

This paper examines the results of the 1984 fishery and provides a forecast of available catch for 1985.

Catch and effort data

Landings of Arctic charr from 1974 to 1984 are summarized in Table 1. Catches and catch per unit effort in both Voisey Bay and Anaktalik Bay increased in 1984. Effort also increased over the previous year, but was still considerably lower than during the period 1977-81. High catch per unit effort values in the offshore areas of Dog Island and Black Island again suggest a movement of charr into the offshore areas.

Landings in Okak Bay decreased from 30.7 t in 1983 to 13.9 t in 1984. This decreased catch was largely the result of the low effort directed in this area. Catch per unit effort was very high and may reflect an abundance of charr at that time in the fishery when peak escapements usually occur. Fishing in Okak Bay began much later (August 8) in comparison with other years. Severe ice along the coast again affected fishing operations in 1984. The Cutthroat area (Fig. 1) outside of Okak Bay experienced the lowest catch, effort, and catch per unit effort in nine years.

Catches of Arctic charr in the offshore fishing areas of Dog Island and Black Island were again apportioned back into Voisey Bay and Anaktalik Bay following the same methodology applied to the Tikkoatokak - Nain Bay stock.

The Antons area is largely an extension of the Voisey Bay area (Fig. 1) and should perhaps be considered as one stock unit similar to the Tikkoatokak - Nain Bay stock. If tag recaptures in the offshore area are excluded, then 88% of Voisey Bay tag recoveries have been from the Voisey Bay - Antons area. Mean age and length of catches from the two areas are also similar. By including the Antons area with Voisey Bay, a more complete evaluation of total stock losses can be evaluated.

Adjusted catch data for Voisey Bay and Anaktalik Bay are summarized in Table 2.

Numbers at age were available from annual commercial sampling programs for Voisey Bay and Okak Bay since 1977. For Anaktalik Bay, numbers at age were available from 1977-78 and 1980-84. An estimate for numbers at age in the 1979

catch was derived as in previous assessments from the average proportion at age for 1977-78 and 1980-82. Tables 3 and 4 summarize adjusted numbers at age for the Voisey - Antons stock and Anaktalik Bay, while Table 5 is a summary of catch at age data for Okak Bay.

Weights at age were calculated from commercial samples (1974, 1977-78 for yield per recruit analysis, and 1982-84 for stock projections) and were converted from gutted head-on to whole weight.

Partial recruitment rates were standardized as the same as those used in a previous assessment (Dempson and LeDrew 1984) and are recorded in Table 6.

Yield per recruit was calculated by the method of Thompson and Bell (Ricker 1975) using partial recruitment values and mean weight at age data. Natural mortality was assumed constant at 0.2. $F_{0.1}$ values were the same as those used in a previous assessment (Dempson and LeDrew 1984) and equaled 0.4 for Voisey Bay, Anaktalik Bay, and Okak Bay charr stocks (Table 6).

Total mortality rate (Z) calculated using the Paloheimo method gave an average value for the Voisey Bay area of 0.58 (1979-80 to 1983-84 excluding 1981-82). Owing to the large variation in catch per unit effort at age data for Anaktalik and Okak bays, an estimate of total mortality was derived from a catch curve. Total mortality rates were 0.52 (95% C.L. = 0.30 - 0.73) for Anaktalik Bay and 0.59 (95% C.L. = 0.46 - 0.73) for Okak Bay. These estimates, however, refer to the average mortality in effect during the period of time fish were recruited into the fishery and may be overestimates in relation to the general decrease in both catch and effort during the past several years.

Cohort analyses for the various stocks were performed using a range of terminal fishing mortalities rates from 0.2 to 0.5. Regressions of F on effort and biomass on catch per unit effort were calculated as an aid in determining the best estimate for terminal fishing mortality in 1984. Effort data used were from the inshore fishing areas only and are assumed to be an index of total effort.

For the Voisey - Antons stock the highest correlation for both F on f and biomass on CPUE were at $F_T = 0.3$ (Table 7). Residuals for predicted values, however, were moderately large at the lower F_T values, but decreased with increasing F_T. The Paloheimo Z of 0.58 suggests an average F of ≈ 0.4, and is an average value for the past several years. From the series of regressions that were calculated, and giving more weight to the residuals, and in consideration of the Paloheimo Z, it was decided that a reasonable estimate for terminal F in 1984 was 0.45. Recruitment estimates for all projections were calculated from the geometric mean of the age 6 population numbers for the years 1977-82.

For Anaktalik Bay, regressions were calculated omitting data for 1978 and 1982. Although correlation coefficients were high for regressions of F on f, they were not statistically significant owing to the small number of years used ($F_T = 0.25$, $r = 0.836$, $p \approx 0.07$). Given the low estimated catch of Anaktalik

Bay Arctic charr in 1984, and the nonsignificant regressions, it was decided that there was insufficient new information to recommend a TAC different from the 8.2 t quota of 1984.

Regression summaries for Okak Bay show an increase in the correlation coefficients with an increase in F_T. A terminal F of 0.25 was selected on the basis of the high correlations and relatively low residuals from predicted values, and a consideration of the low catch in 1984 in relation to the mortality rate estimated from the catch curve.

The projected available catch for the Voisey - Antons stock is shown in Table 8. Fishing at $F_{0.1}$ indicates a catch of 24.8 t is available in 1985, with 26.0 and 26.3 t in 1986 and 1987. This TAC can be apportioned into inshore and offshore regions using the same methodology as for the Tikkoatokak - Nain Bay stock, and results in an allocation of 23.4 t inshore and 1.4 t offshore. Approximately 61% of the inshore catch (Voisey - Antons) from 1974 to 1984 has been from Voisey Bay. This catch distribution could be used to apportion the 23.4 t quota into respective areas.

With F_T = 0.25 in 1984, the projected available catch for the Okak Bay stock in 1985 is 27.3 t (Table 9), and is the same as the TAC in 1984. Projections for 1986 and 1987, assuming the same recruitment as in 1985, result in TACs of 30.0 and 31.6 t respectively.

Projections are influenced by estimates of fishing mortality in the most recent year. With a relatively small time series of data available, irregularities in the data can affect regression results and, therefore, the ability to tune the cohort analyses and key in on the best estimate of terminal F. Tagging projects similar to those which have been carried out on the Tikkoatokak - Nain Bay stock allow for an additional independent estimate of F in the last year. Projections are derived from past data and indicate the catch biomass available for harvest and not necessarily what will be taken. The latter is also dependent on environmental conditions and the actual amount of effort that will be directed in any particular area.

In 1983 areas directly under quota regulation accounted for 35% of the total charr catch from the Nain fishing region. During the 1984 season, quota areas totalled 44% of the Nain region charr catch. By including inner bay catches caught in the offshore fishing areas of Dog Island and Black Island, a more complete evaluation of total stock losses is obtained for assessment purposes. When the Antons area is considered with Voisey Bay as a stock complex similar to the Tikkoatokak - Nain area, a greater proportion of the Nain fishing region Arctic charr landings are evaluated (64% for the 1984 fishing season). Additional area combinations are possible, for example, the Okak - Cutthroat area, and could eventually result in an even greater proportion of total losses which could be assessed.

References

Dempson, J. B., and L. J. LeDrew. 1984. Assessment of Voisey Bay, Anaktalik Bay and Okak Bay Arctic charr stocks in 1983 and projections for 1984. CAFSAC Res. Doc. 84/8. 14 p.

TABLE 1, ARCTIC CHARR CATCH STATISTICS , 1974 - 1984;
SUMMARY OF CATCH, EFFORT, AND SIZE COMPOSITION

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
VOISEY BAY											
QUOTAS						22500	22500	16100	16100	16000	16000
CATCH (KG)	20045	238	12232	22488	33597	21880	11557	16325	7688	2953	8113
EFFORT (MAN-WEEKS)	64	2	45	56	85	59	52	53	38	17	24
C/E (KG)	313	119	272	402	395	371	222	308	202	174	338
%/% > 2.3KG			42.0	35.0	34.0	32.0	17.0	16.0	17.0	16.7	16.4
ANAKTALIK BAY											
QUOTAS						21500	21500	8660	8660	11000	6100
CATCH (KG)	7821	2548	14670	21604	13075	14913	8045	9157	10836	2359	3980
EFFORT (MAN-WEEKS)	28	10	45	63	55	76	53	32	27	24	34
C/E (KG)	279	255	326	343	238	196	152	286	401	98	117
%/% > 2.3KG			36.0	38.0	27.0	20.0	12.0	10.0	11.0	10.9	11.5
OKAK BAY											
QUOTAS								27300	27300	21000	27000
CATCH (KG)	34250	2354	17812	27592	36125	26171	17434	11049	9031	30732	13864
EFFORT (MAN-WEEKS)	105	15	52	107	104	123	65	46	26	147	30
C/E (KG)	326	157	343	258	347	213	268	240	347	209	462
%/% > 2.3KG			29.0	26.0	18.0	11.0	8.0	10.0	7.0	6.5	2.2

Table 2. Summary of adjusted landings of Arctic charr from Voisey Bay and Anaktalik Bay, 1974-84.

	Year										
	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Voisey Bay											
Quota (kg)						22500	22500	16100	16100	16000	16000
Catch (kg)	20513	240	12316	22676	33769	22407	12128	16968	7959	3252	9234
Voisey - Antons											
Catch (kg)	29802	3766	15494	24786	37796	42136	20987	25097	14325	28331	23075
Anaktalik Bay											
Quota (kg)						21500	21500	8660	8660	11000	8200
Catch (kg)	9074	2732	15360	22841	13533	17397	10773	11631	13453	3997	8065

Table 3. Estimated numbers at age for the Voisey - Antons Arctic charr stock unit. Numbers have been adjusted to account for losses in offshore fishing areas.

Age	1977	1978	1979	1980	1981	1982	1983	1984
6	322	622	487	139	77	270	2024	277
7	2109	4398	5042	700	1016	815	3156	2530
8	4076	5402	8133	3518	2694	1724	3407	3677
9	2110	2343	3469	4293	4942	2433	4536	2604
10	1251	1243	1193	1409	2429	1208	1969	1730
11	608	1147	650	547	972	630	1315	884
12	393	382	217	273	420	65	881	439
13	214	382	163	174	44	13	75	414
14	107	192	54	34	-	19	7	98
15	-	95	-	26	-	-	-	21
16	-	48	-	-	8	-	-	-
17	-	-	-	-	-	-	-	31
18	-	-	-	-	9	-	-	-
19	-	-	-	7	-	-	-	-
Total	11190	16254	19408	11120	12611	7177	17370	12705

Table 4. Estimated numbers at age for Anaktalik Bay Arctic charr, 1977-84. Numbers have been adjusted to account for losses of Anaktalik charr in the offshore fishing areas.

Age	1977	1978	1979*	1980	1981	1982	1983	1984
6	99	134	88	89	18	18	37	41
7	599	2202	956	239	497	131	268	483
8	2995	1896	1835	964	1105	930	451	909
9	2098	977	2335	2558	2262	1710	627	1001
10	2145	440	1588	1314	1475	1435	226	699
11	1348	192	1029	659	765	1473	231	440
12	449	134	509	340	298	911	153	430
13	199	77	221	309	94	238	47	300
14	100	38	128	178	54	154	16	82
15	2	38	30	31	1	40		24
16	2	19	12	1	9	15		
17							11	
18								
19						21		
Total	10036	6147	8731	6682	6578	7076	2067	4409

*1979 values generated from the mean proportion at age for 1977-78 and 1980-82.

Table 5. Estimated numbers at age for Okak Bay Arctic charr, 1977-84.

Age	1977	1978	1979	1980	1981	1982	1983	1984
6	84	102	-	26	39	62	318	182
7	84	1228	1227	353	419	314	1307	1002
8	251	4040	4546	2126	791	1004	3056	1521
9	752	2762	3067	3305	1733	859	3815	1403
10	1839	2813	2020	2517	1693	987	3258	988
11	2173	1892	1191	867	922	901	2957	1165
12	3595	1944	541	391	197	406	2180	587
13	1505	1381	469	129	121	105	1002	474
14	1087	256	325	162	60	82	390	394
15	920	511	253	219	51	45	118	93
16	501	153	216	-	-	16	107	29
17	84	205	144	-	34	23	11	10
18	84	51	72	-	-	15	43	-
19	84	51	36	-	-			29
20			36	-	-			
Total	13,043	17,389	14,143	10,095	6060	4819	18,562	7877
Effort	107	104	123	65	46	26	147	30

Table 6. Summary of weight (kg round) at age data, partial recruitment rates and calculated $F_{0.1}$ values for Voisey - Antons, Anaktalik Bay, and Okak Bay Arctic charr.

	Voisey - Antons			Anaktalik Bay			Okak Bay		
	Weight		Partial	Weight		Partial	Weight		Partial
Age	1974, 77-78	1982-84	recruitment	1974, 77-78	1982-84	recruitment	1974, 77-78	1982-84	recruitment
6	1.70	1.25	0.031	1.54	1.38	0.02	1.58	1.14	0.003
7	1.84	1.53	0.240	1.89	1.72	0.212	1.63	1.38	0.056
8	2.11	1.87	0.712	2.20	1.84	0.578	1.76	1.59	0.262
9	2.59	2.23	1.0	2.64	2.04	1.0	2.05	1.72	0.469
10	2.71	2.43	1.0	3.04	2.11	1.0	2.25	1.87	0.829
11	2.86	2.58	1.0	3.15	2.16	1.0	2.30	1.83	1.0
12	3.32	2.56	1.0	3.22	2.01	1.0	2.54	1.93	1.0
13	3.16	2.47	1.0	3.44	2.07	1.0	2.57	1.87	1.0
14	3.90	2.37	1.0	3.03	2.27	1.0	2.75	1.90	1.0
15	4.23		1.0	3.03	1.99	1.0	2.96	1.86	1.0
16				3.16		1.0	3.20	1.59	1.0
17							2.02	2.30	1.0
18							2.45		1.0
19							3.30		1.0
							2.23		1.0
	$F_{0.1}$ = 0.3979			$F_{0.1}$ = 0.4050			$F_{0.1}$ = 0.4013		
	at Y/R of 1.105 kg			at Y/R of 1.143 kg			at Y/R of 0.796 kg		

Table 7. Summary of regressions calculated to calibrate cohort analyses.

Regression	Parameter	F_T 0.20	0.25	0.30	0.35	0.40	0.50
		Voisey - Antons					
F (weighted 9+) vs effort 1977-83	r	0.841	0.857	0.864	0.860	0.849	0.806
	residual	-0.417	-0.382	-0.345	-0.303	-0.263	-0.177
9+ biomass vs CPUE of 9+ fish 1977-83	r	0.858	0.864	0.866	0.865	0.861	0.846
	residual	44963	31688	22835	17509	11762	5113
		Akaktalik*					
F (weighted 9+) vs effort	r	0.841	0.836	0.831	0.824	0.819	0.807
	residual	-0.056	-0.029	0.003	0.037	0.073	0.151
9+ biomass vs CPUE of 9+ fish	r	0.457	0.613	0.690	0.711	0.706	0.677
	residual	3358	-622	-3278	-5176	-6601	-8601
		Okak					
F (weighted 9+) vs effort	r	0.777	0.828	0.868	0.899	0.923	0.954
	residual	0.012	0.057	0.103	0.151	0.200	0.200
9+ biomass vs CPUE of 9+ fish	r	0.311	0.531	0.651	0.731	0.777	0.806
	residual	234	-8473	-13314	-16073	-19301	-22901
11+ biomass vs CPUE of 9+ fish	r	0.694	0.795	0.860	0.899	0.924	0.949
	residual	-2139	-6275	-9034	-11003	-12481	-14551

*Data for 1978 and 1982 omitted. Regressions are not significant owing to small number of years in the calculation.

Table 8. Projection of available catch for the Voisey - Antons Arctic charr stock for 1975-87 from a cohort analysis run with F_T = 0.45.

POPULATION NUMBERS 1/ 3/85

	1984	1985	1986	1987
6	28152	28152	28152	28152
7	27218	22799	22761	22765
8	14736	20803	16957	16932
9	7870	8761	12318	10443
10	5228	4109	4886	6768
11	2672	2729	2255	2639
12	1327	1398	1498	1237
13	1251	693	766	822
14	217	653	388	428
6+	88671	89293	89899	90171
7+	60519	61141	61747	62019
8+	33301	38342	38982	39254
9+	18568	18348	22026	22321

POPULATION BIOMASS (AVERAGE) 1/ 3/85

	1984	1985	1986	1987
6	31726.68	31703.94	31703.94	31703.94
7	35641.09	30193.32	30148.47	30148.47
8	21487.55	29641.98	25128.86	25091.54
9	12904.98	14691.24	20656.57	17511.57
10	9341.33	7507.78	8785.84	12353.30
11	5869.28	5294.88	4374.65	5119.41
12	2498.08	2685.54	2883.37	2382.25
13	2272.82	1286.87	1422.84	1526.79
14	259.35	1163.83	677.66	748.83
6+	121408.38	124169.22	125781.48	126586.11
7+	89673.69	92465.28	94077.46	94882.17
8+	53832.60	62271.97	63928.99	64733.70
9+	32345.05	32630.06	38800.13	39642.16

CATCH BIOMASS 1/ 3/85

	1984	1985	1986	1987
6	346	393	393	393
7	3871	2899	2894	2894
8	6876	8442	7157	7146
9	5807	5876	8263	7005
10	4284	3803	3514	4941
11	2281	2118	1758	2048
12	1124	1074	1153	953
13	1023	515	569	611
14	356	466	271	388
6+	25887	24786	25964	26298
7+	25540	24393	25571	25897
8+	21669	21494	22677	23003
9+	14793	13052	15520	15857

Table 9. Projection of available catch for the Okak Bay Arctic charr stock for 1985-87 from a cohort analysis run with $F_T = 0.25$.

POPULATION NUMBERS 8/ 3/85

	1984	1985	1986	1987
6	31353	31353	31353	31353
7	79503	25505	25639	25639
8	26246	64187	20419	20526
9	13992	20116	47323	15055
10	5810	10191	13652	32117
11	5787	3867	5989	8023
12	2916	3690	2122	3287
13	2354	1859	2025	1165
14	1957	1501	1020	1111
15	462	1248	824	560
16	144	295	685	452
17	70	92	162	376
6+	170594	163903	151214	139664
7+	139241	132550	119861	108311
8+	59738	107045	94222	82672
9+	33492	42859	73802	62146

POPULATION BIOMASS (AVERAGE) 8/ 3/85

	1984	1985	1986	1987
6	32294.62	32376.23	32376.23	32376.23
7	90769.19	31558.06	31723.37	31723.37
8	36641.95	87970.09	27985.52	28132.12
9	20624.76	28682.56	67475.94	21465.81
10	8925.50	14781.38	19802.31	46585.09
11	8528.01	5322.03	8241.27	11040.65
12	4532.01	5355.35	3080.40	4770.06
13	3544.69	2614.64	2847.71	1638.00
14	2994.22	2144.42	1457.97	1587.93
15	691.99	1745.31	1152.10	783.30
16	184.37	352.23	818.80	540.50
17	96.45	158.79	279.63	650.03
6+	217827.77	213061.07	197241.24	181293.09
7+	185533.15	180684.84	164865.01	148916.87
8+	86763.96	149126.79	133141.64	117193.50
9+	50122.01	61156.70	105156.12	89061.38

CATCH BIOMASS 8/ 3/85

	1984	1985	1986	1987
6	207	39	39	39
7	1383	707	711	711
8	2410	9219	2933	2948
9	2413	5301	12658	4027
10	1648	4902	6566	15448
11	2132	2129	3297	4416
12	1133	2142	1232	1908
13	886	1046	1139	655
14	749	858	583	635
15	173	698	461	313
16	46	141	328	216
17	90	64	112	260
6+	13478	27324	30058	31576
7+	13270	27286	30020	31538
8+	11888	26579	29309	30827
9+	9469	17359	26376	27879

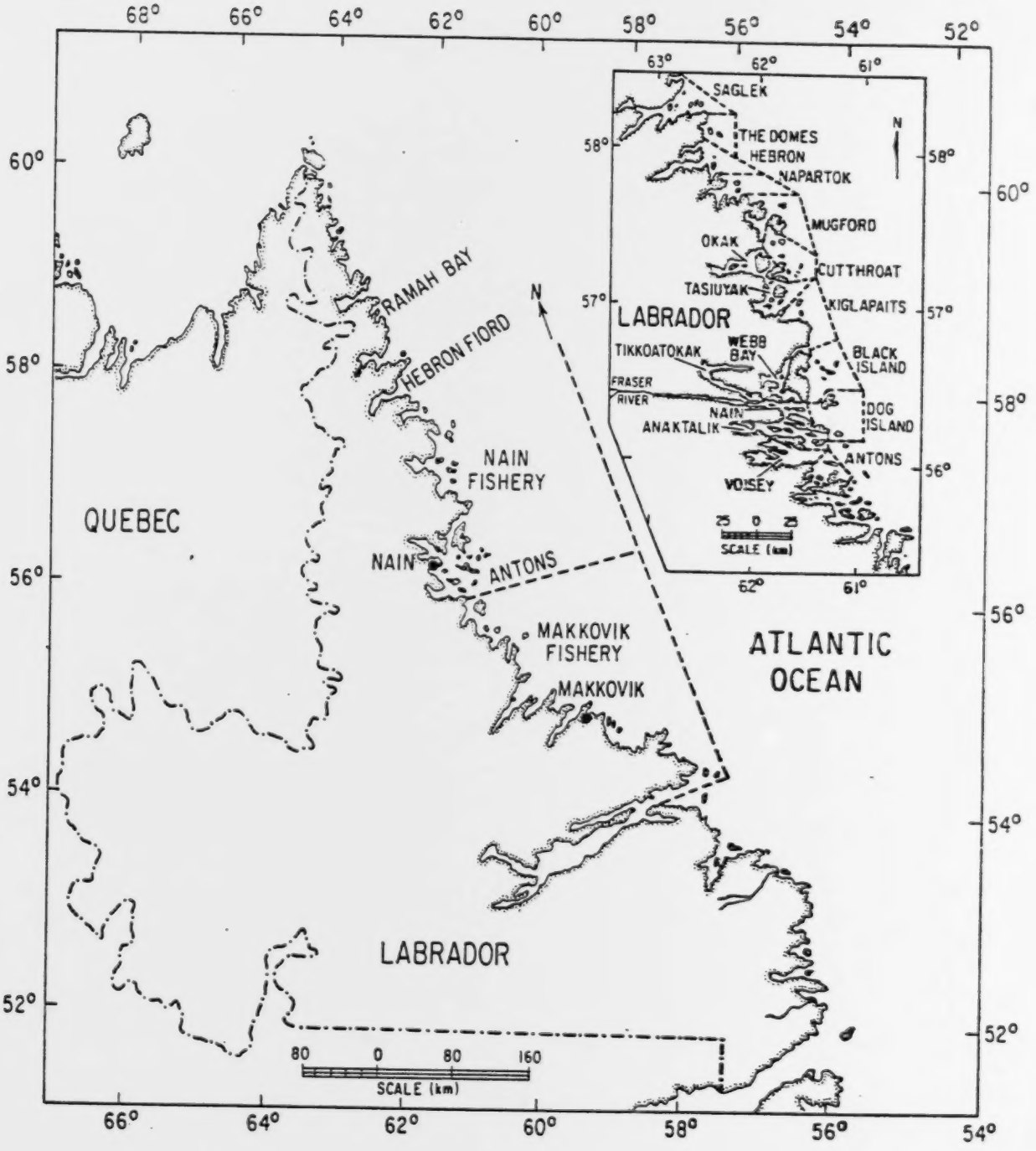

Fig. 1. Location of the Nain and Makkovik Arctic charr commercial fishing regions in northern Labrador. Insert illustrates the fishing area breakdown within the Nain fishing region.